come, while in the case of the really backward races the premature application of modern culture and educational methods would spell disaster. Wise supporters of the League of Nations do, at any rate, recognise that part of the "sacred trust" of a mandatory Power is to provide for the education and training of the races under its tutelage on lines suitable to their stage of development.

Criticism of any scheme of internationalism is easy, and the difficulties which have to be overcome are enormous. The verdict of history on the whole is adverse. But against this must be set the fact that the world has never been faced with conditions similar to those of to-day, or with the possibility of a crisis such as would be involved in another war. Is the realisation of the danger which threatens civilisation strong enough to overcome the jealousies, the bickerings, and the rivalries of States which are loosely joined in a confederation, or even united under a "world-law"? Present conditions are not favourable to the probability of success. Although we may speak of nations as if they were individuals, one of the strongest of social forces which operate in the case of the majority of the individual members of a community is absent. Nations, like corporations, have no conscience, and the force of the moral judgment and the opinion of others is not operative. Whereas in a civil society public opinion largely determines conduct and force is the ultimate sanction, in a confederacy of nations force is the only sanction. The balance of power alone will influence any member or group of members who may wish to defy the body as a whole.

It is no answer to criticism to say that in a world-State, or in the conditions of international amity towards which the supporters of the League of Nations would wish to progress, such occasions for misunderstanding would not arise. Apart from the differences in degree of culture, there is among nations as they exist to-day a variety in outlook which is the outcome of history, tradition, education, and environment. The effect of this variety in outlook was patent to those who, during the war, took part in operations with the composite armies which fought on some of the Allied fronts. The outward semblance of unity of action was attained only by a constant smoothing away of difficulties and misunderstandings arising out of national differences of temperament and outlook.

Differences of temperament are easy to note, but difficult to reduce to a scientific formula. Nor do we know how far they are fundamental and ineradicable. The comparative study of racial psychology on modern scientific lines is almost an unexplored field. National character, in so far as it is the product of tradition and education, may be susceptible of modification. Most nations to-day are the result of a fusion of races the members of which live more or less in amity, and this lends support to the view which holds to the ultimate possibility of a wider unity. Against this, however, must be set the view of some anthropologists who are inclined to attach increasing importance to race as a persisting element in character. In this country, for instance, notwithstanding common environment, common tradition, and common institutions, differences of occupation and of class feeling seem, in a general way, to go with differences of racial type. Should a more extended observation tend to confirm this view, it would suggest that any form of international confederation which aims at obliterating nationality and race would scarcely attain enduring success.

What Relativity in Science Implies.

The Reign of Relativity. By Viscount Haldane. Pp. xxiii+430. (London: John Murray, 1921.) 21*s*. net.

THERE is no need to begin this notice of Lord Haldane's book with a general reference to its scope and purpose. It is well known that, though the book deals with many problems of science, it is not scientific in the technical meaning of the term; it is philosophy, and, as philosophy, it includes every realm of human experience, and, therefore, science, in its synopsis. It will be more interesting to readers of NATURE to select certain particular problems of science which are also problems of philosophy.

The first part of the book deals mainly with the principle of relativity, the metaphysical basis of which is brought out with wonderful clearness. Lord Haldane achieves this, not so much by his direct exposition, which is thorough, as by his delicate and subtle critical comparison of two methods of applying the principle in mathematics and physics, that of our English mathematician, Prof. Whitehead, and that of Einstein himself. His exposition of both these writers is masterly. The chapter on Einstein is the clearest account of his theory and method that has yet appeared; possibly it appears clearer than it otherwise would from the fact that it follows the account of Whitehead, which is certainly more difficult. This does not mean that Lord Haldane's exposition has made either writer easy to understand, but it has made it possible for anyone who cares to give the necessary attention and concentration to understand them both. Those who have argued *a priori* that any exposition of the principle of relativity by Lord Haldane must be defective and inconclusive because he is not a mathematician and therefore does not use or know how to use the language which enables mathematicians to express their equations have only shown that they mistake both the purpose and the nature of the value of mathematical methods. It is just because mathematics is restricted to abstract quantitative measurements that its system of symbols is so effective an instrument. Mathematicians are the first to acknowledge this. They know it is they who are handicapped when it comes to laying bare the metaphysical concept, handicapped by the very ease with which they are able, by the manipulation of symbols, to simplify the most complex and complicated quantitative equations.

When we say of anything that it is relative, the question immediately follows: Relative to what? Absolute relativity is either a contradiction in terms, as if one should say a round square, or it is an expression for that extreme form of scepticism which professes to be a universal negation. Now, undoubtedly the first impression we receive of the general principle of relativity does dispose us to identify it with the principle of universal doubt. On this aspect of the great problem Lord Haldane is clear and pronounced from the first sentence of his preface to the end of his book. To the question, Relative to what? he replies, Relative to knowledge; and knowledge is not itself an abstract relation, but a concrete universal. In this he is following Hegel, who first brought to light, in its modern form, the dialectical nature of thought. "Knowledge," says Lord Haldane, "is dynamic. It is an effort to transcend the apparently given. It is always pointing beyond itself" (p. 140). It is from this point of view that the comparison of Whitehead and Einstein is instructive. Both are concerned, and concerned only, to present to us a science of Nature. Both reject the absolute: there is neither a space-time system nor a material, dependent or independent of the observers attached to it, which can serve as a norm by which to regulate the relations of different space-time systems. Both reject the principle of action at a distance: it is inconceivable as fact and useless as a principle. An interesting, though perhaps a minor, point in which Lord Haldane notes a difference between them is that, while for Whitehead the element out of which our concept of Nature is constructed is the event, and the object is a derivative notion, for Einstein the event seems to depend on the notion of object. In this Lord Haldane thinks Whitehead is more faithful than Einstein to the fundamental principle of the four-dimensional space-time continuum. Apart from this, it is Einstein who has made the greater advance to the full philosophical concept. Whitehead halts. He cannot surrender the notion that Nature in its existence is self-contained, that it stands for a reality which in the last analysis is closed to mind. Is this concept of a reality closed to mind a necessity of mathematical and physical science? Some philosophers would agree with Whitehead in saying, Yes. They are the new realists, and are here criticised from that point of view. On the other hand, Einstein and Eddington seem very definitely to say, No, and to be able to prove it. Lord Haldane suggests that Whitehead's own persistent question, in regard to any and every specified point-event—the question, Whose space-time? or, What space-time system?—in its implications is the negation of his own conclusion. This brings out Lord Haldane's foundational fact. Knowledge is a universal within which all distinctions fall. It is not, and cannot be, conceived as an abstract relation between two self-subsistent and existentially exclusive realities, mind and Nature.

Let us now turn to another question, which is equally pressing as a scientific problem, and equally significant as a philosophical problem—the quantum theory. Lord Haldane makes only a brief reference to it (p. 106), but it is in a certain sense even more relevant to the concept which it is his main purpose to expound, the concept of degrees of reality, than the principle of relativity itself. For the quantum theory shows that in scientific explanation, however far we are able to pursue it, we are brought up finally against a fact which positively forces us to appeal to a character of knowledge in plain contradiction of our scientific principle of explanation.

On p. 114 there is a delightful account of the curious statue erected to Gauss and Weber in Göttingen. It is made the occasion of expounding the work of those mathematicians who, as Lord Haldane says, "nearly three-quarters of a century since, prepared the way for thinkers like Einstein and the interpreters of the doctrine of quantitative relativity." But it is also curious to remember that at the same time there was living in Leipzig another Weber, the philosopher and psychologist who has given his name to the famous law of psycho-physics. Weber's law was the first definite discovery of the fact on which the quantum theory rests. He discovered that in sensible experience changes are not continuous—that is, do not correspond to the continuity of the changes of the physical stimulus, but occur in discrete quanta. He was a parallelist, and thought that changes in the physical environment were concomitant with changes in sensation. He never suspected, probably would have found it difficult to conceive, that changes in the physical world are discrete. Planck's quantum theory is the discovery that the same fact which Weber found to characterise the psychical world characterises the physical world; that energy is emitted, not continuously, but in discrete quanta; that, as Lord Haldane says, we may even have to regard space as a discrete manifold. This comparison is not a fanciful notion, nor purely imaginary. The whole problem was discussed by Henri Poincaré in "Science et Hypothèse" before Planck's discovery. Poincaré cites Weber's law as actual proof that the concept of mathematical continuity is only a postulate, declares that it is unverifiable, and suggests that it may be disproved or superseded. This is peculiarly significant in regard to Lord Haldane's concept of the concrete universal, the concept that reality is relative to the character of knowledge.

The practical gain in such a concept when we are dealing with biology and with the mental sciences is the topic of chap. vi. of the book. The most striking thing about the new scientific revolution is the havoc it is making of the once unchallengeable and universally accepted notions at the basis of the purely mathematical sciences. It is not, for example, Newton's law of inertia, primarily and mainly based on empirical observation, which is suspect. It is the much more fundamental law, the law of the equivalence of action and reaction, a purely rational principle, which seems now to be on its trial. The whole direction of scientific speculation in the nineteenth century was towards the conscious goal of mechanical interpretation. Scientific advance was practically identified with the confident anticipation that all the biological and mental sciences, even including such purely human interests as art and religion, would be mechanistically explained. The new spirit and the new direction in scientific speculation at least recognise that the abstract can never comprehend the concrete; and this recognition more than anything else is bringing about the *rapprochement* between science and philosophy, so long and so unreasonably estranged.

H. Wildon Carr.

A New Book on Cactaceæ.

The Cactaceae. By N. L. Britton and J. N. Rose. Vol. ii. (Publication No. 248.) Pp. vii+239+40 plates. (Washington: The Carnegie Institution of Washington, 1920.)

All cultivators of cacti and all botanists who are interested in this remarkable family of plants will feel satisfaction in knowing that at last we have in the English language a standard up-to-date monograph of the natural order Cactaceæ, which is universally recognised as being the most difficult of all flowering plants to study. With the exception of a few scattered but excellent papers upon them by Drs. Britton and Rose, Dr. Engelman, and Berger, this is the first work in the English language that gives a complete account of the order as we know it to-day. This fine book is so excellently planned and so fully illustrated as to be a long way in advance of the very unsatisfactory German works that have hitherto held the field, and will be found to be a real boon to all who study these plants.

From the introduction to the first volume (a notice of which was published in Nature for September 11, 1919) we learn that Drs. Britton and Rose at first intended to monograph only the Cactaceæ of North America, but, happily, upon a proposal made by Dr. D. T. MacDugal, the plan was extended to include the whole of the family. Extensive preparations were made and a large army of workers was enlisted to collect and photograph the species in their native habitats, the result being that the authors have had at their disposal a larger amount of living and other material, accompanied by field-notes, drawings, etc., than any other students of this group have ever been able to obtain. As the types (when existing) of the older as well as of modern species have also been consulted, the authors have been able to detect and correct many errors of determination that are found in existing monographs.

Vol. ii. is of quarto size, well printed and profusely illustrated with photographs, drawings, and coloured plates, which, it is a pleasure to note, are nearly all originals. There are good keys to the tribes, subtribes, genera, and species, so that, taking into account the aid afforded by the figures, there should be no great difficulty in naming cultivated specimens when in flower.

Each tribe, subtribe, and genus is separately characterised, and the type of each genus indicated. Under each species the synonyms, with the date of their publication, a description, men-